Lin-Lin Chen, Tom Djajadiningrat, Loe Feijs, Jun Hu, Steven Kyffin, Lucia Rampino, Edgar Rodriguez, Dagmar Steffen

Design and semantics of form and movement

DeSForM 2015

Aesthetics of interaction: Dynamic, Multisensory, Wise

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Edited by

Lin-Lin Chen

Tom Djajadiningrat

Loe Feijs

Jun Hu

Steven Kyffin

Lucia Rampino

Edgar Rodriguez

Dagmar Steffen

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S. Colombo[1], T. Djajadiningrat[2], L. Rampino[1]
1 Design Department, Politecnico di Milano, Italy
2 Philips Design, The Netherlands

Tangible, Smart and Dynamic Objects

How the New Aesthetics Affects Meaning and Experience

Origins and meanings of Aesthetics of Interaction

The expression "Aesthetics of Interaction" (AoI) has different meanings and can relate to different concepts, according to the context where it is used [1, p.270]. In order to better understand why and how this expression has entered the design field, and especially the *industrial* design area, it is interesting to step back to its origin and its primary meaning.

Aesthetics of Interaction started to emerge in the field of Human Computer Interaction (HCI), when "effort is [...] put into designing interactive systems beyond rational and functional requirements" [1, p. 270]. Meaning that, next to the systems' functionality, performance, and usability, attention started to be paid also to other elements of human experience, i.e. the emotional, perceptual and sensory ones. In this effort to overcome the mere functionality, the notion of aesthetics came into play, since "the concepts and vocabulary of aesthetics and critical theory have much to offer HCI, because they emphasize qualities and issues that HCI is obviously concerned with in interaction: experience, symbolic density and cohesion, beauty, enlightenment, social justice, dialogism, identity and the self, form and meaning, taste and judgment [...]" [2, p. 2357].

The question to answer in this "aesthetic turn" was the following: how could the notion of aesthetics, usually related to the appreciation of beauty in arts, be applied to interactive systems, and to the idea of interaction itself? Indeed, interaction is not an object, but "a phenomenon that emerges in-between people and digital artifacts. It is not inside of the artifact. It is continuously going on and changing over time." [3, p. 245].

New philosophical approaches and strands were adopted in order to answer the question. In particular, Schusterman's pragmatist aesthetics was taken as reference to explain that "aesthetic is not something a priori in the world, but a potential that is released in dialogue as we experience the world; it is based on valuable use relations influencing the construction of our everyday life" [1, p. 271]. If aesthetics was no more in objects but in the dynamic relation between users and objects, it could be applied to the design of interactive systems.

We are now far away from the concept of aesthetics as related to the object's intrinsic beauty or to the sensory perception of the user. The idea of beauty is still there, but the pleasure felt by the user is no longer related to just the sensory features of an object, but emerges in interaction, in performing actions, in being challenged by open systems that require imagination to be understood, in perceiving emotions, in being engaged.

In HCI, this new view on aesthetics brought to build what Udsen and Jørgensen [4] call a "functionalist approach" to aesthetics. Indeed, many theories in the field started to argue that aesthetics should be aimed at making

"attractive things", which "work better" [5]. Aesthetics was intended as a means to improve the system's usability. Although many subsequent theories and approaches, especially in the design field, challenged this view, it still has the merit to be the first attempt to move beyond the mere cognitive skills in the interaction with smart systems, towards the investigation of a broader view of human experience in interaction. One that encompasses its three fundamental aspects: the sensory-motor, the cognitive and the emotional ones.

Among the first scholar to refer to such a broader view and to mention this "trinity of interaction" was Kees Overbeeke: "We believe that respect for man as a whole should be the starting-point for design. For the sake of analysis, man's skills, which are used when interacting with products, may be considered on three levels, the wholly trinity of interaction: cognitive skills, perceptual-motor skills and emotional skills. In other words, knowing, doing and feeling." [6, p. 8].

Aesthetics of Interaction in industrial design

It is now worth addressing why the notion of Aesthetics of Interaction can be connected to product design. Aesthetics intended in its primary sense, as the beauty related to the physical appearance of arts objects or nature has always been part of industrial design theories and practice [4]. In industrial design, traditionally product aesthetics equals visual appearance. In this view, the user is seen "only as an onlooker and not as an actor". [7, p. 298]. Whereas still primarily connected to visual appearance, in the last two decades aesthetics in product design has started to be investigated also in relation to other senses, bringing to the emergence of a more "synesthetic" idea of beauty [8].

Moreover, beauty and pleasure in design have been recently connected not only to (multisensory) appearance, but also to other aspects of products, such as the product use. As argued by Jordan [9] based on Tiger [10], there are different kinds of pleasure emerging by the interaction with products. Among them, psycho-pleasure emerges in the use of products and can be generated by the pleasant way in which a product performs an action, under the control of the user.

Already in these theories, aesthetics in product design enlarges its meaning, and embraces not only the product's perceivable features, but also its use. However, in all these cases (be pleasure related to appearance or use), when talking about aesthetics in product design, products are meant as traditional objects, artefacts characterized by certain physical features and functions, which remain static and defined by the designer once for all.

Nevertheless, in the last decade, the design field has been heavily affected by the technology revolution. Indeed, artefacts are getting embedded with sensors, electronics, processors, smart devices and smart materials. These elements make products dynamic and interactive. Thus, "a domain which was once considered pure industrial design is faced with many interaction design challenges" [7, p. 294]. It is in this historical moment that aesthetics of interaction enters the product design field and starts to be investigated as an essential part of the user experience also with physical artefacts.

Dynamic and interactive products

In our discourse on aesthetics, compared to what we call traditional products (the static ones), smart and interactive products have mainly two distinctive features: their behavior turns from passive to active; their appearance becomes *dynamic*, i.e. it can change over time in a reversible and pro-active way.

Concerning the first feature - the *active behaviour* - we can state that traditional products do not really "behave", but respond to the user's behaviour or actions on it. The product's performance is pre-defined by the designer, and enabled by the user. At the most, we can talk about a passive behavior, because it is the user who acts on the product and makes it behave in certain ways: the control is always in the user's hands. In smart products, the product's behavior becomes dynamic, and pro-active: products are able to perform actions, activities, functions,

independently by the presence of users, or as an active response to it, to the environment or to information coming from networks, smart spaces and devices. Products can even take decisions and behave accordingly.

The focus on behavior in smart products has been recognized as a fundamental aspect for design: "an essential characteristic of intelligent products and systems is that they portray behavior in interaction" [11, p. 3]. Therefore, in the design of smart tangible products, "the emphasis shifts from an aesthetically controlled appearance to an aesthetically controlled interaction, of which appearance is a part." [12, p. 66]. Thus, if appearance is just a part of an aesthetic interaction, another layer of complexity is added to smart products: this appearance becomes dynamic as well, requiring new paradigms and approaches to control it. Indeed, the second feature of smart products is their *dynamic appearance*: physical products can now change their tactile qualities (e.g. temperature and texture), their shape, light, colour, sound, smell, etc. in a proactive manner. These sensory changes occurring in products can have different aims. For instance, they can be used for delighting and attracting users (at a sensory level); for engaging users in interaction (at an affective level); for conveying information to users (at a cognitive level) [13].

Obviously, these two changes - (inter)active behavior and dynamic appearance - require a shift in how *aesthetics* should be conceived in product design, since both new appearances and new forms of interaction are emerging. As Ross and Wensveen pointed out, "designing such products and systems requires an aesthetic that goes beyond traditional static form aspects. It requires a new language of form that incorporates the dynamics of behavior." [11, p. 3] Due to these transformations, aesthetics of interaction – first emerged in HCI – legitimately enters the product design domain, breaking the traditional rules, approaches and tools of industrial design and opening new and exciting challenges. As stated by Lim at al. "a fair amount of research attempts to explore the nature of aesthetics in the design of interactive artifacts […]— e.g. showing that aesthetics are based not just on visual appearances of an artifact but more on the holistic experience of its use." [3, p. 240]

Emerged in the product design area to face the new dynamic features of smart products, aesthetics of interaction can still be applied to traditional products, where not only the pleasure generated by appearance, but also the pleasure arising in use is taken into consideration. When applied to "static" products, AoI can be seen as an evolution of the concept of *usability*, where the aim is not only to perform effectively, but also to feel pleasant sensations while performing an action on, or with, products.

In brief, we can affirm that, in designing for an aesthetic interaction, the fourth dimension - time - becomes the fundamental variable, the core of every design choice. At this regard, Anna Vallgårda [14] introduces the concept of "temporal form giving". This new kind of form giving, together with the (traditional) physical form giving and the performances of the interaction gestalt are defined by Vallgårda the "trinity of forms" that she proposes as a framework to unfold the practice of interaction design. Indeed, if in traditional product design, time was considered relevant only in designing the user's actions on products, when it comes to smart and dynamic objects, time becomes essential also in the design of the product's features and behavior.

Clearly, the concept of aesthetics of interaction applied to tangible products needs further theoretical investigation. Many questions are still open and paradigms keep changing, as technology and society rapidly evolve, making it difficult to take other than quick and partial pictures of reality.

Nevertheless, many big challenges in this area are being investigated by scholars and some of them are addressed by the papers presented at the DeSForM 2015 conference (for more reasoning on these issues, see also the Proceedings of the previous DeSForM conferences, all available at the following link: www.northumbria.ac.uk/about-us/academic-departments/northumbria-school-of-design/research/desform/previous-conferences-and-proceedings/).

We summarize these challenges in the following paragraphs, also by briefly explaining how the works presented at DeSForM 2015 can contribute to a fruitful debate on these issues.

Challenges

What new frameworks are needed to understand aesthetic interactions in design?

"[…] the scope of design is changing from human/artifact interaction, mainly focused on opening up the functionality of a product, toward a broader approach that seeks to enhance interpersonal and societal values, including personal, aesthetic, and socio-cultural ones, through the application of intelligence (i.e., smart electronics) in artifacts." [15, p. 70]

If products are no more static and "predictable" as they were before, if they become intelligent, open, and dynamic, then the industrial design community needs to update its traditional theoretical frameworks and principles, adopting a new and open view on products: "[…] products and services do not have to be as fixed as they were before. Since they are part of an interconnected network of other products, services and people that are changing over time, so are the products and services. It is a dynamic network with updates, added propositions, new connections, new functions, etcetera." (DeSForM2015 paper by van Kollenburg, Deckers, Gardien and Hummels)

It is interesting at this regard to mention the concept of "opera aperta" ("open artwork"), introduced by Eco in 1962 [16]. Indeed, as Jones (1992) noted, "designers need to acknowledge their relative ignorance of "temporal design" and can perhaps learn from the "time arts" (music, dance, theatre, film, novel, poetry, etc.) how to compose-in-time with some sense of beauty." (Jones, cited in [17]).

The concept of "opera aperta" refers exactly to artworks – mainly novels, but also musical compositions and performances - opening up to the aspect of time and qualified by being "unfinished". In Eco's view, "opera aperta" is an artwork that allows multiple interpretations, that permits to communicate ambiguous and multi-purpose ideas, that offers itself to endless possibilities of understanding. "The fact that these creations are not finally defined, gives them an openness towards the beholder perception, interpretation or use." [18, p. 331]. The "opera aperta" does not suggest a pre-ordered and univocal set of values, but rather a field of possibilities. For this reason, it always requires an active intervention, an operative choice by the reader or the beholder. Compared to the traditional static idea of an artifact (being it an object d'art or a product), the "opera aperta" has the capacity of being 're-created' each time a new user starts interacting with it. "The momentary aspect of Eco's Opera Aperta opens up to the aspect of time." [18, p. 331]

Interestingly enough, the DeSForM2015 paper "People Research for Eco-system Propositions" by van Kollenburg et al. presents a theoretical framework supporting "open" modalities of user-centered research to be embedded in the design process of dynamic and interconnected eco-systems: "[…] the four people research activities have no specific order of execution; they are neither linear nor iterative by definition. They are dynamic and there is no predefined order or static link to the design process. Hence there is no predefined starting or ending point for the process. Depending on the type of questions and status of the project the design research team can decide where to start and what to do after." Thus, according to the authors of this papers, for designing an open product, an open process in needed.

The attempt to generate new frameworks for the aesthetics of interaction in products is exemplified by the paper "The Aesthetic of Digital Objects" by Folkmann, which presents a new framework where the issues of dynamic appearance, hidden function, and product openness are all taken into consideration.

The paper "Searching for balance in aesthetic pleasure in interaction" by Cila, Rozendaal, Berghman and Hekkert aims to "unravel the general principles that underlie aesthetics of interaction". It describes how visual aesthetic principles (e.g. Gestalt principles) can be applied not just to appearance, but also to "the movements performed while interacting with a product", to generate aesthetic pleasure in interaction. These principles, according to the authors, can adapt to both dynamic and traditional static products.

What new tools can be adopted to design aesthetic interactions?

"Although there has been a drastic increase in the research of aesthetics of interaction, we still lack well-defined practical knowledge of how to design aesthetic interactions." [3, p. 239]

In addition to developing new theoretical frameworks, there is also a need to supply designers with methods and tools helping them in designing for an aesthetic interaction. That is, designing in an integrate manner all the (dynamic) features of the artifact – being them behaviors and/or appearances – and the actions/reactions of the user, so that all this "ingredients" can generate a holistic and pleasurable interaction experience.
There is thus a need to develop specific design tools, to be applied in given phases of the design process, from the concept phase (see, for instance, the paper by Patrizia Marti), to the development phase (see the paper by Stienstra, Bogers and Frens).

The paper "Poetry in Design" by Patrizia Marti describes an approach to use contemporary poetry as a tool to experience cultural elements and embed them in the design of meaningful interactions. In Marti's view, poetry is a precious vehicle able to nourish product design with reflection and sense-making, differentiating it from merely functional solutions. It is also interesting to notice that the Dutch poet Jan Glas, which Marti involved in her teaching activity, explained that he uses: "[…] words with nuanced meanings to allow the reader's imagination to run wild and form a feeling, meaning or image independently. He highlighted the active role of the reader in experiencing and making sense of the poem." This is again an interesting, although not explicit, reference to the concept of "opera aperta".

As Lim at al. noted, it is important to know "what is possible to be manipulated when designing interactions—i.e. attributes of interaction" [3, p. 239]. The DeSForM 2015 paper "Designerly handles" by Stienstra et al. aims to provide designers with new kinds of design tools, which allow them use their typical "pathic" skills and knowledge while designing interactive products, to overcome the limitation of the tools borrowed by other disciplines (e.g. computer science). These tools' goal is to allow reflection-in-action while designing interactive products, by bringing the digital qualities into the physical realm, to manipulate them in the design process.

How can user experience and emotional bond with (dynamic) products be enhanced?

"The prospect of beauty of interaction may not only tempt users to engage in interaction, but also tempt them to persevere in interacting." [7, p. 296]

The experience generated during the interaction with products has been widely explored in the industrial design field [19]. Such experience is commonly defined as the mix of three levels: experience of meaning, emotional experience, and aesthetic experience. These three components of experience have been studied in traditional static products, especially in relation to their appearances and functions. They now need to be reframed in order to address the category of interactive and tangible products. Relevant questions in this area are: how is meaning created in interaction? How to exploit the product's dynamic features and "smartness" to improve the user's life? How to address technology in products towards the creation of pleasant experiences?

The DeSForM 2015 paper "Design for Attachment: an explorative search for product qualities that enhance our emotional bond with digital products" by Niemantsverdriet and Frens explores how dynamic features and behaviours of digital products can adapt to user's needs and habits in order to create emotional attachment over time.

The contribution "Towards the maturation of design: From smart to wise products" by Schifferstein, Ozcan and Rozendaal reflects over the evolving role of smartness in products. The authors argue that products' smartness should turn into *wisdom*, in order to create better experiences and to evoke desirable behavior, which "contribute to the user's and society's subjective well being".

In the paper "Enriching the Expressiveness of Products with Life Experiences", Tung and Tseng investigate how people associate products with their life experience: the aim is to identify elements that can become inspirations for designing original and meaningful products. Indeed, the authors argue that designers increasingly use metaphors that recall common life experiences (such as natural events like thunders during a storm, or common human behaviors, like participating in sports) to enrich the emotional attachment to products: "Through reminding the user of a personal experience and evoking a corresponding emotional response, a unique and meaningful relationship between the user and the product is formed." Even if examples refer mainly to static products, nevertheless the suggested classification can provide an interesting playground also for dynamic products.

How does the concept of "material" change in the aesthetics of interaction paradigm?

"Every object made by man is the embodiment of what is at once thinkable and possible." [20, p. 17]

Nowadays, the "material of invention" [20] that designers have at their disposal to define new products can be designed as well. Vallgårda introduced the idea of "computational" composite in design: "I propose that we begin to understand the computer as a material like any other material we would use for design, like wood, aluminum, or plastic. That as soon as the computer forms a composition with other materials it becomes just as approachable and inspiring as other smart materials." [21]
Not only can computer be regarded as a new material, but also traditional materials are becoming smart, i.e. able to sense environmental changes and react to them accordingly, with a fast, local, and adaptable response, modifying one or more of their features (mechanical, optical, electrical, magnetic, chemical or thermic ones) [22]. As a consequence, smart materials can be used as active elements in the interaction between the user and the artifact, assuming the role of both sensors and actuators: the material itself detects the user's action and responds by giving him/her a feedback.

In the smart materials field, designers and chemical engineers are now starting to cooperate. This collaboration is important in order to fill a gap, as underlined by Franinović and Franzke in the DeSForM 2015 paper "Luminous Matter": "The active properties of novel materials themselves appear to be hard to work with, reflected by the lack of examples that exploit them in design fields.[…] Dealing with materials on a nano scale not only requires specialised facilities, but also removes the creator from the direct sensing and handling of the material. Tacit knowledge of materials plays an essential role in design and arts, as such intimate relationship with a novel material enables a designer or artist to explore its aesthetic potential." The experiments with electroluminescent paper described by Franinović and Franzke shows a potential for collaboration with material scientist and engineers: novel materials can feed into design research and, vice versa, design experiments can stimulate the development of novel materials.

In her contribution to DeSForM2015, Rognoli proposes two emerging material experiences: dynamism and imperfection. "Both are nowadays considered very promising material experiences in terms of creating meaningful interactions and, as a consequence, user's attachment to the product. […] dynamism and imperfection share a changing and evolving nature able to break the monotony of the idealized "perfect" and "static" relationship usually established between user and artefact." The Sui Bag presented by Rognoli is thus a good example on how designers could take into account materials and manufacturing processes for creating meaningful interactions.

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